

USING OF PROSTHETIC BIOMATERIALS IN LARGE ANIMALS: MODERN CONCEPTS ABOUT ABDOMINAL WALL DEFECTS APPROACH

UTILIZAREA BIOMATERIALELOR PROTETICE LA ANIMALELE MARI: CONCEPTE MODERNE ASUPRA ABORDĂRII DEFECTELOR PERETELUI ABDOMINAL

Ciprian OBER*, Aurel MUSTE, Liviu OANA, Nicolae MATEȘ, Florin BETEG, Sebastian VEREȘ

University of Agricultural Sciences and Veterinary Medicine, 400372 Cluj-Napoca, Calea Mănăștur no. 3-5, Cluj, Romania, E-mail: cipri_ober@yahoo.com

Manuscript received: August 13, 2008; Reviewed: November 10, 2008; Accepted for publication: November 17, 2008

ABSTRACT

The development of prosthetic biomaterials revolutionized surgery for the repair of abdominal wall hernias in humans. A tensionfree mesh technique has drastically reduced recurrence rates for all hernias compared to tissue repairs and has made it possible to reconstruct large ventral defects that were previously irreparable. Abdominal wall defects (hernias, eventrations, eviscerations) in large animals (cattles, horses) present also a high incidence, leading to morbidity, low productions, infertilities, poor performances. We used in our study polypropylene mesh which facilitated the reconstruction of large tissue defects in 6 animals (3 cows and 3 horses) and was not associated with any serious complications. The results of this study allow us to say that the use of prosthetic biomaterials is superior to simple suture repair and represent a modern and safely procedure in large animals. The biocompatibility of these biomaterials for long periods warrants further investigations.

Keywords: cattle, horse, abdominal wall defect, prosthetic biomaterial, polypropylene mesh.

REZUMAT

Dezvoltarea biomaterialelor protetice a revoluționat chirurgia defectelor peretelui abdominal la oameni. Tehnicile „tension-free” au redus foarte mult rata recidivelor herniare comparativ cu simpla rafe tisulară și au făcut posibilă remedierea defectelor parietale largi, iremediabile în trecut. La animalele mari (cai, vaci), defectele peretelui abdominal (hernii, eventrații, eviscerații) prezintă de asemenea o incidență ridicată și duc la o rată crescută de morbiditate, producții scăzute, infertilități și performanțe reduse. Noi am utilizat în studiul nostru meșe din polipropilenă, care au facilitat remedierea unor defecte largi ale peretelui abdominal la 6 animale (3 cai și 3 vaci), intervențiile nefiind asociate cu complicații severe. Rezultatul studiului nostru ne permite să susținem că utilizarea biomaterialelor protetice comparativ cu simpla rafe a breșelor abdominale largi reprezintă o abordare modernă și sigură la animalele mari. Oricum, biocompatibilitatea pe termen lung a acestor biomateriale necesită încă investigații.

Cuvinte cheie: vacă, cal, defect parietal abdominal, biomaterial protetic, meșă polipropilenică.

DETAILED ABSTRACT

O serie de studii au scos în evidență faptul că utilizarea unui biomaterial protetic în cazul închiderii defectelor peretelui abdominal duce la o scădere semnificativă a ratelor de recidivă [4] and [6], iar ca atare în medicina omului aceste biomateriale iau locul simplei rafii a breșelor. Totuși, utilizarea lor poate duce la serioase complicații post-operatorii, cum sunt infecția plăgii, seroamele, rejecția meșei, aderențele și fistulele stercorale.

Într-un interval de doi ani, șase pacienți (trei cai și trei vaci) au fost tratați chirurgical din cauza unor defecte largi ale peretelui abdominal (Tabelul 1). Pentru închiderea breșei abdominale s-au utilizat meșe protetice din polipropilenă (fig. 1) (D-tek, Polypropylene Mesh), meșe care au fost plasate înafara breșei abdominale (subcutanat premusculo-aponevrotic, epifascial sau fixare onlay) (Fig. 3). Am procedat la tehnica descrisă de Van der Velden și Klein [11], deși în medicina omului cel mai întâlnit procedeu este acela prin care meșa este plasată în interiorul breșei abdominale (preperitoneal, retromuscular sau fixare sublay). Singurele complicații post-operatorii au fost un ușor disconfort abdominal manifestat de cai, dezvoltarea de seroame la cinci pacienți și un hematom la unul dintre pacienți (Tabelul 2). Cu acordul proprietarului, un pacient a fost eutanasiat datorită înrăutățirii progresive a stării de sănătate, suprapusă peste vârsta înaintată, dar nu am putut corela acest lucru cu implantul protetic, necropsia nefiind efectuată.

Deși utilizarea meșelor protetice în cazul nostru nu a dus la serioase complicații post-operatorii la pacienții operați, se impun totuși examene de laborator și monitorizări clinice pe termen lung a pacienților, pentru a se putea aprecia fidel biocompatibilitatea meșelor și rezistența peretelui abdominal protezat.

INTRODUCTION

In the past, hernia surgery and abdominal wall reconstructions frequently have used tense sutures to approximate and close a hernial port or defect. This has led to wound dehiscence, recurrent hernias and non-healing of the wound due to tissue ischaemia, with the sutures cutting through the soft tissue [5]. Large hernia require closure safe closure because they interfere with athletic activities or normal parturition and they are cosmetically unsightly [2].

The first use of prosthetic mesh for ventral hernia repair in humans was in the 1960s, when Usher [9] and [10] presented the advantages of knitted polypropylene mesh for the repair of anterior abdominal wall hernias. The successful repair of an abdominal wall defect is based on a tension-free closure

to allow wound repair, a better collagen restoration and prevention of recurrence. Polypropylene mesh is strong, has excellent tissue incorporation, and is relatively inexpensive. Unfortunately, it has been found to be associated with a high rate of adhesion formation to underlying viscera [5]. Visceral adhesions can result in intestinal obstruction, pain, and fistula formation. Another complication include persistent incisional drainage, peritonitis, infection of the implant or problems associated with anaesthesia [8] and [11].

Anyway repairing of large abdominal wall defects using prosthetic meshes in horses and cows is a good option, knitted polypropylene mesh being reportedly successful in over 80% of large animal patients [8] and [11].

MATERIALS AND METHODS

Three adult horses weighing 400 to 500 kg and three adult cows weighing 350 to 450 kg were examined and surgically treated because of large abdominal defects (Table 1).

Preoperative preparations. The animals was supposed for a diet of 24 hours, was effectuated body hygiene and a completely clinical examination. It was placed an intravenous catheter (jugular vein) for the administration of perfusions. A nonsteroidal, anti-inflammatory drug (flunixin meglumine 1,1 mg/kg bwt i.v.) and an antibiotic that provides activity against a broad spectrum of microbes (potassium penicillin G – 22.000 iu/kg bwt i.v. q 8h) were administrated perioperatively..

Anesthetic considerations. General anaesthesia was induced in horses with a combination of Xylazine 0,3 mg/ kg bwt and Ketamine 2,2 mg/kg bwt, i.v. via jugular vein catheter. The animals was intubated orotracheally and maintained on inhalant anaesthesia using Isoflurane. For cattles we used a combination of Xylazine 0.02 mg/ kg IV and Butorphanol 0.02 mg/kg IV, associated with local anesthesia on surgical site.

Contention. The animals were placed in dorsal (horses) and lateral recumbency (cows), opposite of the abdominal wall defect. The surgery place was aseptically prepared



Fig. 1. Polypropylene mesh and wires used
Fig. 1. Meșa din polipropilenă și firele utilizate

Table 1. Signalment, duration of disease, clinical signs, side and hernial contents of patients
Tabelul 1. Semnalmentele pacienților , durata evoluției bolii, semnele clinice, partea afectată și conținutul herniar

<i>Species Speciile</i>	<i>Breed Rasa</i>	<i>Age (years) Vârsta (ani)</i>	<i>Duration of evolution Durata de evoluție</i>	<i>Clinical signs Semne clinice</i>	<i>Side Zona afectată</i>	<i>Hernial content Conținutul herniar</i>
1. Horse	Mixed breed	9	3 months	abdominal swelling, abdominal discomfort, infrequent obstipation	left	small bowel
2. Horse	Mixed breed	7.6	5 weeks	inguinal swelling, tenesmus	right	epiploon
3. Horse	Mixed breed	16	2 months	abdominal swelling, abdominal discomfort,	left	small bowel and epiploon
4. Cow	Red Holstein	4	3 weeks	abdominal swelling, inapetence	right	small bowel
5. Cow	Mixed breed	6	1 month	abdominal swelling	right	epiploon
6. Cow	Mixed breed	4.5	2 weeks	abdominal swelling, dilated abdomen	right	epiploon

and draped for surgery. Instrumentary used was the proper surgery instrumentary for this kind of interventions. The prosthetic meshes used contain polypropylene filament and have dimensions of 30 X 30 cm. (D-tek, Demophorius Limited, Cyprus). The wires used for mesh fixing was also polypropylene structure (Fig. 1).

Surgical technique. The goal of surgery was to reduce the abdominal contents and close the abdominal defect so that herniation of abdominal contents cannot recur. This

supposed surgical manual labors in aseptic conditions. So, we performed an elliptical skin and subcutaneous tissue incision on long axis of tumefaction and hemostasis was permanently assured by forcipressure and vascular ligatures. Hernial sac was bluntly dissected and abdominal contents was reduced by twisting the sac and milking the contents through the ring (Fig. 2). It was appreciated the abdominal breach (Fig. 3) and the prosthetic mesh was adjusted for adequate dimensions



Fig. 2. Reducing of abdominal contents
Fig. 2. Repunerea conținutului abdominal

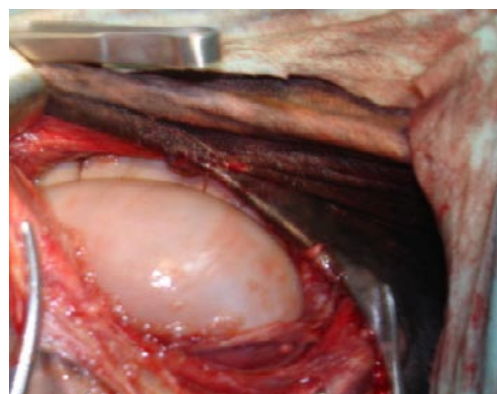


Fig. 3. Appreciation of abdominal breach
Fig. 3. Aprecierea breșei abdominale

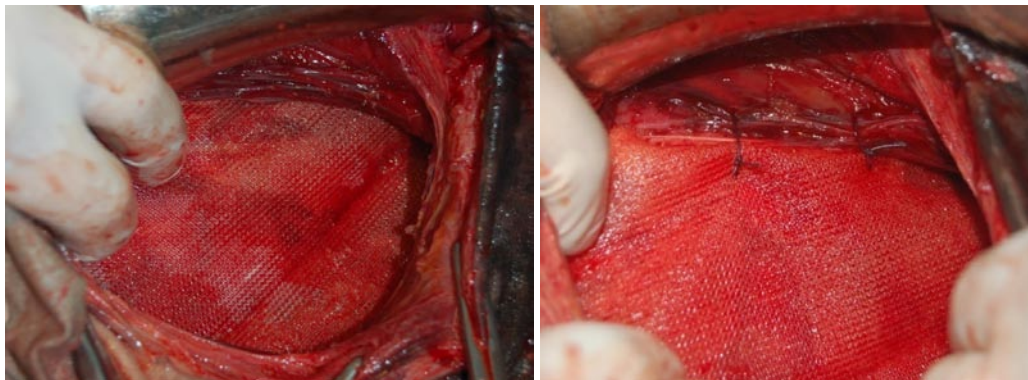


Fig. 4. Positioning and fixing of the prosthetic mesh in onlay position

Fig. 4. Poziționarea și fixarea meșei protetice în poziția onlay

(in vivo it must surpass the edges of abdominal breach with 1 cm approximate). Then the mesh was fixed by onlay method (subcutaneous premuscular-aponeurotic or epifascial position) (Fig. 4).

Fixing of the prosthetic mesh in musculature was realised using #3 polypropylene sutures in simple interrupted patterns, in “U” upright; the method was described by Bellas [1]. Application of wires was made under fingers protection, avoiding in this way puncture of a bowel from abdominal cavity. (implanted mesh must be stretched, do not having pleats). For preventing trickling of peritoneal liquid at the level of sutured wound, that create a vicious healing, after fixing of prosthetic mesh, the subcutaneous connective tissue was mobilised and sutured above the mesh, using #3 Vycril, in continous patterns. This sutures also offer protection against superficial infections and improve cosmetic aspect [2]. The wound was closed by interrupted patterns using surgical #4 silk, then the surgical site was sprayed with oxytetracycline spray (Alamycin).

RESULTS AND DISCUSSION

After anamnesis and clinical exams, resulted that in case of four patients (cases no. 1, 4, 5, 6) the abdominal wall defects had a traumatic origin and in case of two patients (cases no. 2 and 3) the causes was backed muscular efforts because of solicited and recurrent tractions.

The only effective treatment for this defects is surgery to restore integrity and maintain function of the abdominal wall and prevent incarceration and strangulation of intra-abdominal content. The positive effects of the use of a mesh on recurrence of the hernia stimulated the search for an optimal mesh with high biocompatibility, low adhesion formation and low infection rates. In human medicine a large number of clinical trials have

been published to compare the different types of mesh, emphasizing tissue adhesion formation [5], recurrence [11] and infection [12].

To date a large number of surgical meshes are available for abdominal wall reconstruction. They all differ concerning tissue ingrowth, chance of infection and rate of recurrence. Surgical meshes on the market are either made of absorbable synthetic, non-absorbable synthetic or organic material derived from human fascia lata or porcine small intestinal submucosa. The enormous variety in materials available implicates important differences concerning interactions between surgical mesh and micro-organisms.

We used for our cases polypropylene mesh and this facilitated the reconstruction of large tissue defects. Postoperative was observed little general modifications in all patients, because of inflammatory reaction induced by prosthetic meshes (temperature, pulse and respiration rates increased during first 48 h postoperative). Also the horses presented depression, mild abdominal pain and behavior colic-type (flank-watching) and they were treated with flunixin meglumine (1.1 mg/kg bwt i.v.). The cows did not present any clinical major changes.

Because an “ideal mesh” is not available yet, the foreign body induced some local complications (Table 2).

Haematoma, developed at the surgical site by one horse, was effect of local venous or arterial compromise and it was resolved with incision and drainage after a local anaesthesia. Seromas, common exsudative-inflammatory phenomenons induced by prosthetic mesh were developed by all patients during 2 weeks postoperative (fig. 5). We refered to puncture of collections in most lower point and were applied drainages, in the standing.

Horse 3 developed a complicate infection at surgical site (fig. 6). We prompt removed skin sutures, applied drainage, and topical therapy to prevent dehiscence

Table. 2 Macroscopic local abnormal findings seen in first 14 days after implantation
Tabelul 2. Modificări macroscopice locale observate în primele 14 zile post-operator

Macroscopic findings	First week postoperative	Second week postoperative
Seromas	6	-
Haematomas	1	-
Local infections	-	1

of the hernia repair. Anyway, this was associated with worsened health status and with the owner according the horse was proposed for euthanasia. We cannot say what kind of role presented the mesh here, because the necropsy was not performed.

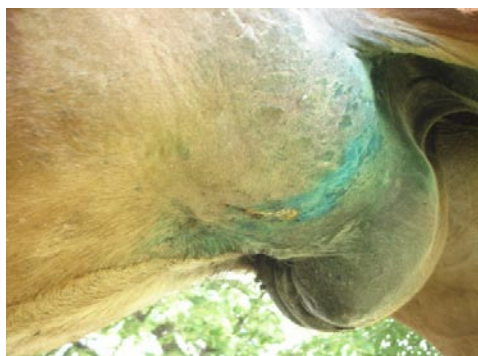


Fig. 5. Seromas
Fig 5. Seroame



Fig. 6. Mesh infection
Fig. 6. Infecția meșei

Although associate with this kind of mesh positions the risk of mesh infections is higher [2], we agree with van der Velden and Klein for placing the polypropylene mesh on the outside of abdominal wall defect. The placement is easier and in this way we did not have any serious complications, the patients being totally recovered (excepting horse 3). We know that the extensive dissection required for this method has a 20% wound complication rate [2], but using drain placements and keeping the animals more days in hospital decrease

this rate. We agree with this method also because it is easy to apply, the mesh being placed superficially, above the external abdominal muscle. In case of eventrations, we made the implants by omentalisation, that means a suture of an omental pedicle, internal on circumference of mesh. It was made this thing in hope of preventing the most important complications induced by the contact of prosthetic meshes of polypropylene and abdominal bowels: formation of adhesions and stercoral fistulas [5]. In case of inguinal hernias, the peritoneum being intact, the prosthetic mesh was not in contact with abdominal bowels.

Although the technique used by Elce et al. [2] is classic, with doubled sheet of mesh placed, we observed good results using a single sheet placed outside of the hernial ring (must be considered in our cases also economical aspects). We hospitalised the patients from the study between 21-40 days. From discussions with the owners, after discharge from hospital, we did not note any other complications after long-term follow up. Not all abdominal wall defects require surgical repair [3] and [13]. Some can be treated conservatively, using compressive elastic abdominal bandages and restricted activity until fibrous tissue bridges the defect [3]. The abdominal wall defects in large animals can be also managed by laparoscopic techniques [7]. The author placed the mesh without tension to the peritoneum, underlying abdominal fascia and internal abdominal oblique muscle with 18 staples. For us, using a mesh for the repair of large abdominal wall defects in horses and cows without a primary simple raphia was a good choice. The best placement of the mesh at the level of abdominal wall (inside versus outside the hernial ring) remain to be sustained by further investigations. Anyway, we must suggest good discussion with the owner, against costs of the interventions, especially when the hernioplasty procedures are performed in cows.

ACKNOWLEDGMENTS

We thank to all the team from Department of Surgery, Faculty of Veterinary Medicine from Cluj-Napoca, in the preparation of this work.

REFERENCES

- [1] Bellas P: Contribution à l' étude du "gros nombril" du veau. Cure chirurgicale par pose d'une crinoplaque, Thèse de doctorat vétérinaire, Lyon, 1987.
- [2] Elce Y.A., Kraus B.M., Orsini J.A., Mesh hernioplasty for repair of incisional hernias of the ventral body wall in large horses, *Equine vet. Educ.* (2005) 17(5): 252-256.
- [3] Freeman D.E., Management of ventral incisional hernias in large horses: a surgical challenge, *Equine vet. Educ.* (2005) 17(5): 247-251.
- [4] Luijendijk R.W., Hop W.C., van den Tol M.P., et al., A comparison of suture repair with mesh repair for incisional hernia, *N. Engl. J. Med.* (2000) 343:392–398.
- [5] [Matthews B.D.](#), [Pratt B.L.](#), [Pollinger H.S.](#), [Backus C.L.](#), [Kercher K.W.](#), [Sing R.F.](#), [Heniford B.T.](#), Assessment of adhesion formation to intra-abdominal polypropylene mesh and polytetrafluoroethylene mesh., *J. Surg. Res.* (2003) 114(2):126-32.
- [6] Morris-Stiff G.J., Hughes L.E., The outcomes of nonabsorbable mesh placed within the abdominal cavity: literature review and clinical experience, *J Am Coll Surg* (1998) 186:352–367.
- [7] Rijkenhuizen A.B.M., Laparoscopic repair of a traumatic ventral abdominal hernia using a mesh. *Equine vet. Educ.* (2005) 17: 243-247.
- [8] Tulleners E.P., Fretz, P.B., Prosthetic repair of large abdominal wall defects in horses and food animals, *J. Am. vet. Med. Ass.* (1983) 182:258-262.
- [9] Usher F.C., A new plastic prosthesis for repairing tissue defects of the chest and abdominal wall, *Am J Surg* (1959) 97:629–633.
- [10] Usher F.C., The repair of incisional and inguinal hernias, *Surg. Gynecol. Obstet.* (1970) 1:525–530.
- [11] [Van der Velden M.A.](#), [Klein W.R.](#), A modified technique for implantation of polypropylene mesh for the repair of external abdominal hernias in horses: a review of 21 cases, *Vet Q.* (1994) 2:S108-10.
- [12] Van't R.M., de Vos van Steenwijk P.J., Bonthuis F. et al., Prevention of adhesion to prosthetic mesh: comparison of different barriers using an incisional hernia model, *Ann. Surg.* (2003) 237:123–128.
- [13] White N.A., Incisional hernia after abdominal surgery in the horse, *Equine vet. Educ.* (1996) 8:308-312.